Simultaneous red, green and blue liquid crystal laser arrays

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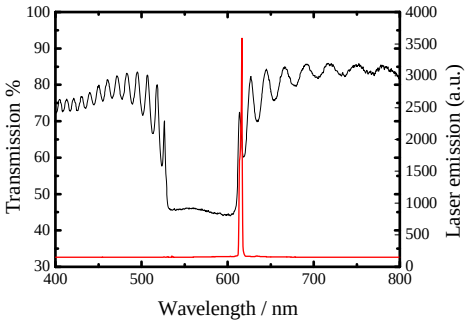
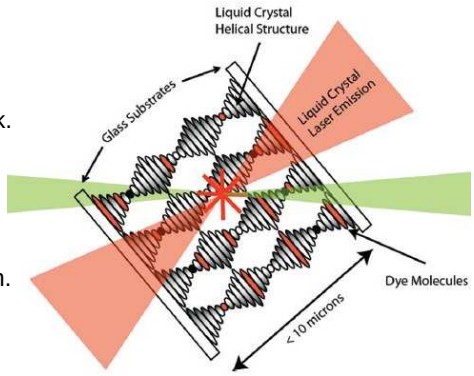
Making a band-edge liquid crystal laser



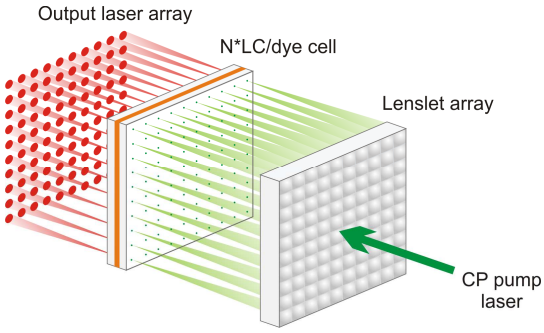
(Above) The photonic band gap in a chiral nematic liquid crystal. Lasing emission occurs at the long band-edge.

- **Chiral nematic liquid crystal – DFB cavity**
  Periodic refractive index – distributed feedback.
  Photonic band-gap (PBG) (reflection band).
  Chiral pitch determines lasing wavelength.
- **Laser dye – Gain medium**
  Absorption max. matches pump wavelength.
  Fluorescence max. matches lasing wavelength.
- **Pulsed laser input – Optical pump**
  Typically: 5ns pulse, 6 µJ/pulse, 4 Hz.



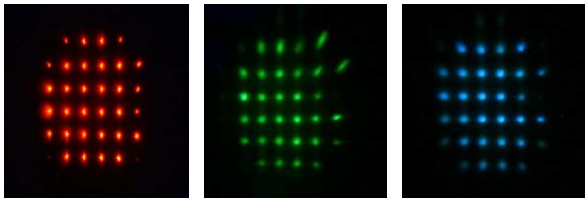
(Above right) When excited with an optical source (green) dye molecules fluoresce. Distributed feedback from the chiral LC structure ensures that stimulated emission (red) occurs perpendicular to the cell.

Monochromatic laser emission



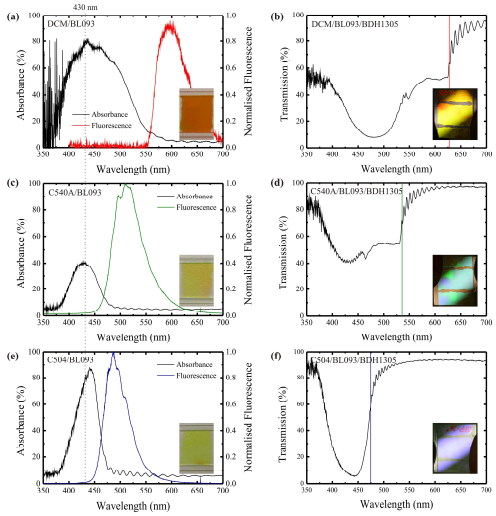
(Above) Pump laser focussed through a lenslet array onto a chiral nematic LC gives rise to an array of monochromatic LC lasers.

(Below) By changing the dye and chiral pitch length, we obtain laser emission in the red, green and blue.



- Focus pump laser into LC cell using lenslet array [1].
- Monochromatic laser array output.
- **Wavelength tuning** with change in chiral pitch (temp., E-field, chiral dopant concentration).
- Array recombinable into **single monomode output**.

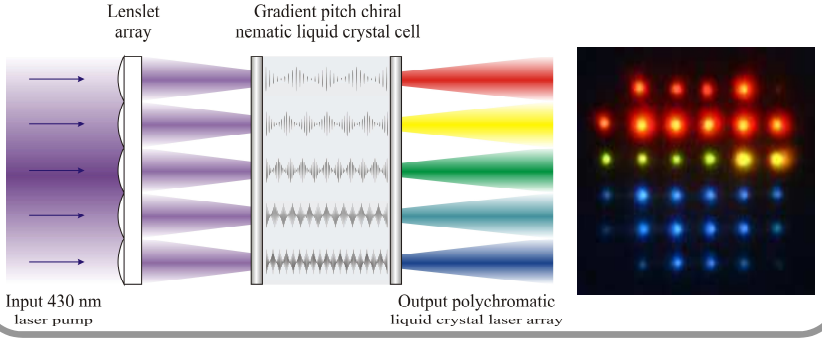
Simultaneous polychromatic laser emission



- **Gradient pitch** LC cell [2].
- **Single pump beam** (430nm, focussed array).
- Simultaneous **multi-wavelength emission**.
- Recombine into **single white light source**.
- Applications in low-cost, high colour resolution **laser displays**.

(Left) Absorption and transmission spectra for three different dye/LC combinations, used to provide red, green and blue LC lasing.

(Below-left) A single wavelength optical pump beam excites a dye-doped gradient pitch LC cell, generating simultaneous polychromatic laser emission (below-right) in the red, green and blue.



COSMOS
Coherent Optical Sources using Micromolecular Ordered Structures

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References:

[1] S.M. Morris, P.J.W. Hands, S. Findeisen-Tandel, R.H. Cole, T.D. Wilkinson, H.J. Coles, Optics Express, **16** (23), 18827-18837, (2008).

[2] P.J.W. Hands, S.M. Morris, T.D. Wilkinson, H.J. Coles, Optics Letters, **33** (5), 515-517, (2008).